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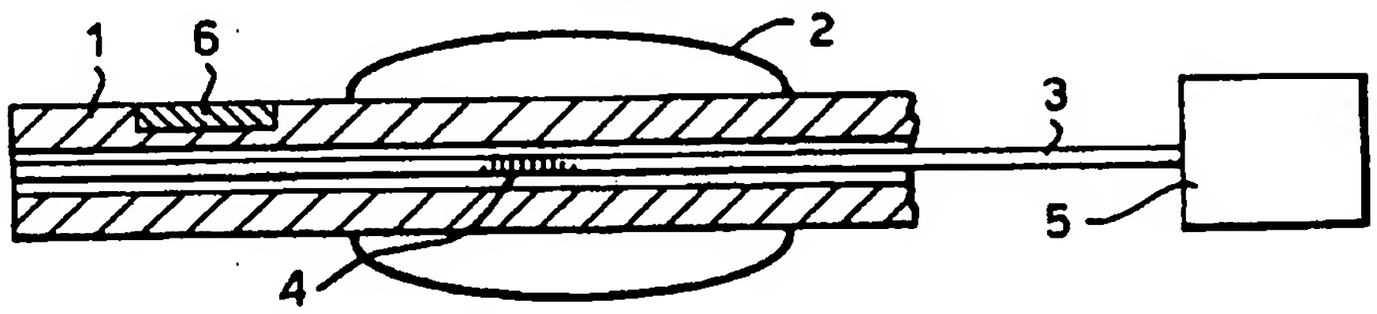
(54) Blood pressure measuring device

(57) A hollow needle incorporates a fibre optic cable 3 for monitoring blood pressure. Pressure and pressure variations cause compression of the fibre optic cable, the resulting strain causing a modification of the Bragg wavelength of a grating 4 written into the fibre optic cable. Pressure measurement is achieved by monitoring the wavelength of light reflected back from the grating in a measurement system 5 The hollow needle may comprise a catheter 1 or a hypodermic needle. A glass sphere may be incorporated at the end of the fibre optic cable. Deformation of the sphere caused by pressure variations may exert pressure on a grating written in the cable. Alternatively the surface of the sphere may form an interferometer for measuring pressure variations and a grating may be found in the fibre to allow temperature measurements also to be made. The device may be adapted for external use.

Fig.1.



GB 2 308 888 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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Fig.1.

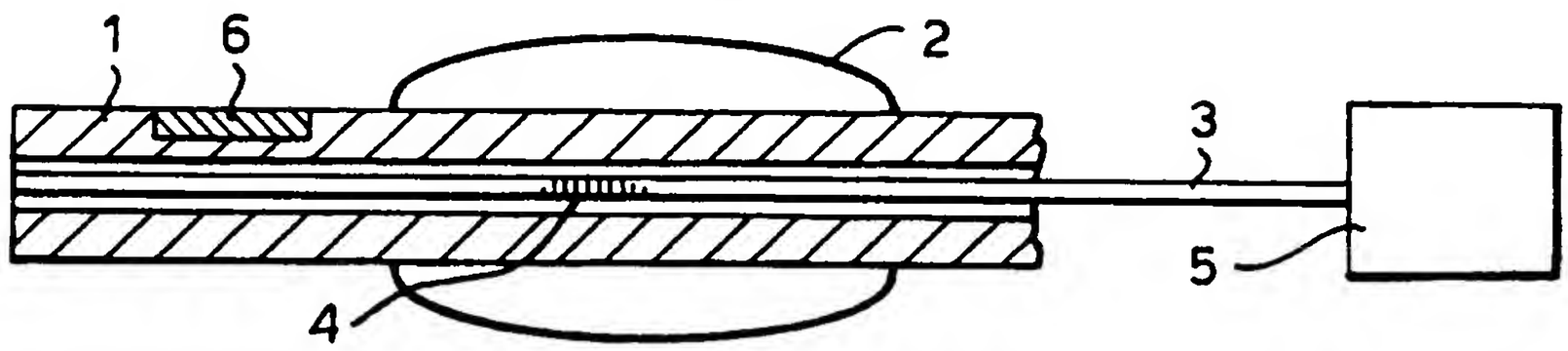


Fig.2.

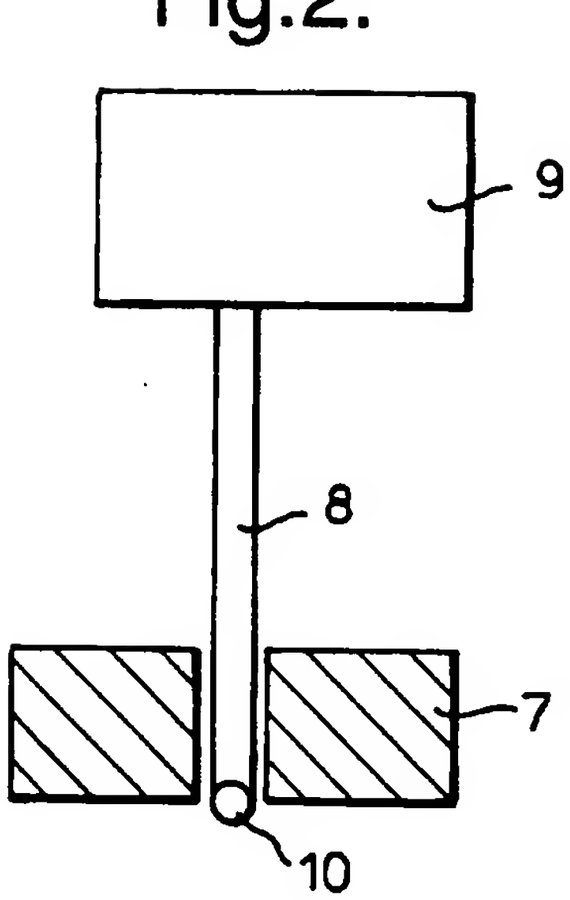


Fig.3.

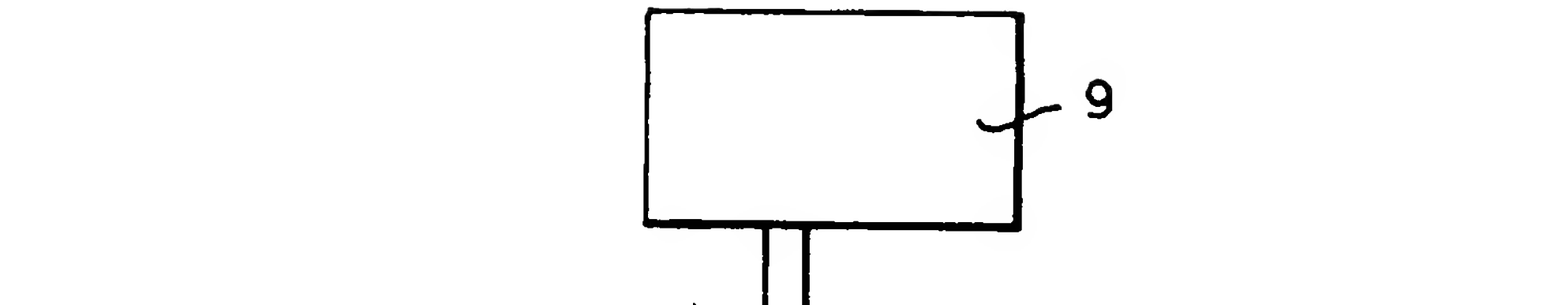
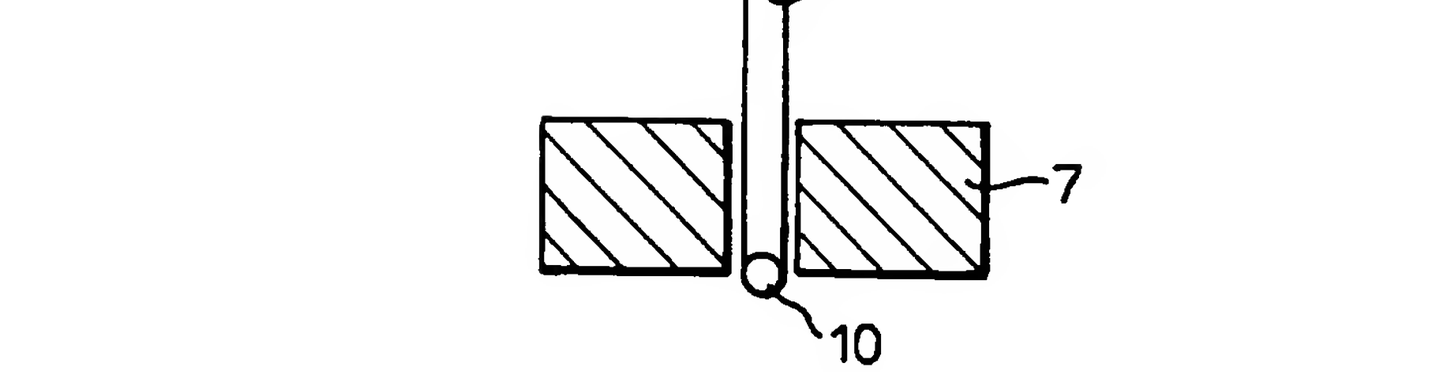


Fig.4.



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PRESSURE MEASURING DEVICE

The invention relates to devices for the measurement of pressure, particularly for medical use, for the measurement of a patent's blood pressure, for example.

The conventional method of blood pressure measurement via the use of a stethoscope and cuff has the disadvantage of being operator-dependent.

Current devices for the measurement of pressure in chambers or vessels of the heart are based on manometric or piezoelectric methods. In the first method, inaccuracies occur due to it being essentially an external measurement technique and the second involves the use of electrical signals which ideally should be avoided in the region of the heart.

The present invention seeks to mitigate the above disadvantages of known devices.

According to one aspect of the invention a device for measuring blood pressure in a human or animal body comprises hollow needle means for insertion into a blood vessel and a fibre optic cable located within the hollow needle means wherein the fibre optic cable incorporates pressure sensing means.

According to another aspect of the invention a device for measuring blood pressure in a human or animal body comprises a sensor head for external use incorporating a fibre optic cable wherein the fibre optic cable incorporates pressure sensing means.

One measurement technique employed by the invention depends on the variability of the Bragg wavelength of a grating incorporated within the fibre optic cable. The grating is formed by a variation in the refractive index of the fibre core written when the fibre is drawn. The Bragg wavelength of reflected light from the grating is a function of temperature and strain of the fibre at the site of the grating.

A second measurement technique is an interferometric one.

In a first embodiment of the invention, the pressure sensing means comprises an optical grating which is written into the fibre optic cable. When the fibre is compressed, the Bragg wavelength of the grating varies, mainly as a result of the refractive index changes in the fibre core. These effects are known; see for example Proceedings Paper No. TU2.2 pp 27-30 "9th Int. Optical Fibre Sensors Conference May 1993" by J Dakin et al. Measurement of the variations in Bragg wavelength thus provides a measure of the pressure or strain experienced by the fibre optic cable. ——

In a second embodiment, the pressure sensing means comprises a hollow glass sphere bonded to an end of the fibre optic cable. Pressure on the sphere causes it to reduce its diameter. Deformations of the sphere may then be monitored optically via the fibre optic cable. In one known measurement technique, the sphere surfaces form a low finesse Fabry-Perot interferometer; see, for example Proceedings SPIE Vol 1795 pp 2-5 (Sep 1992) by J Dakin et al. As the mechanical compliance of a hollow sphere is higher than solid body (such as a fibre

optic cable) this second embodiment has a greater sensitivity to pressure variation than the first.

It is possible to combine the optical grating and hollow glass sphere embodiments mentioned above by bonding such a sphere to an end of a fibre which includes a grating. It is known that an optical grating can also be used for temperature measurement (see for example our co-pending application GB 9526587.2). Hence by employing Fabry-Perot techniques and monitoring Bragg wavelength this third embodiment can be used to simultaneously monitor blood pressure and temperature (either of the blood or skin surface, depending on whether it is being used intravenously or externally.)

In a fourth embodiment, the pressure sensing means comprises a hollow glass sphere in which is secured a portion of the fibre optic cable, said portion incorporating an optical grating. Pressure on the sphere causes it to reduce its diameter, hence compressing the portion of the cable secured within the sphere. By monitoring the Bragg wavelength using a known technique, see for example Electronics Letters Vol 32. No. 2 (18 Jan 1996) by J Dakin et al, blood pressure measurements can be made.

Any of the above embodiments may be used externally or intravenously.

The hollow needle means may comprise a hypodermic needle or a catheter or any other suitable type of invasive device.

If a catheter is used, this may take the form of a balloon angioplasty catheter which may have multi-lumens

through which the fibre optic cable is fed and, optionally, a guide-wire may be fed.

The hollow needle means may incorporate a radio-opaque material so that its location can be tracked by X-rays.

As a further option, and to avoid the possibility of the fibre optic cable coming into contact with blood, the end of the fibre optic cable adjacent to the hollow needle means tip may be coated with a blood-compatible polymer, eg. polyurethane.

If desired, the tip of the hollow needle means and/or the hollow glass sphere may also be so-coated.

Advantageously, the present invention measures blood pressure optically requiring no introduction of electrical conductors or electrical potentials or currents into the body, thereby being electrically safe and avoiding electrical interference from external sources.

Other advantages are its small size, compatibility with computer interfacing for data logging, and a sensitivity of 0.1psi.

The embodiments of the present invention are also suitable for short term (eg. during clinical procedures) and long term monitoring.

Some embodiments of the invention will now be described, by way of example only, with reference to the drawings of which;

Figure 1 is a schematic diagram of a device for measuring blood pressure intravenously using a catheter,

Figure 2 is a schematic diagram of a device for measuring blood pressure externally,

Figure 3 is a schematic diagram of an alternative device for measuring blood pressure intravenously, using a hypodermic needle and

Figure 4 is a schematic diagram of a further alternative device for measuring blood pressure intravenously.

Referring to Figure 1, an invasive device comprises a balloon angioplasty catheter comprising a catheter body 1 and a balloon 2. The catheter body 1 is provided with several lumens, one of which houses a fibre optic cable 3 which incorporates a grating 4. The end of the fibre optic cable which comes into contact with the blood has a polyurethane coating.

The end of the fibre optic cable 3 remote from the catheter body 1 is connected to an optical measurement system 5. The catheter body 1 incorporates a radio-opaque section 6.

In operation, the catheter body 1 is inserted via the skin into a blood vessel. As blood flows past the end of the fibre optic cable 3 the resulting pressure and pressure variations compress the fibre optic cable 3. The fibre optic cable 3 responds to the resulting strain by a modification of the Bragg wavelength of the grating 4 written into the fibre optic cable 3. By monitoring the wavelength of light reflected from the grating 4, the measurement system 5, is able to monitor blood pressure at the tip of the catheter 1.

Referring now to Figure 2, a sensor head 7 incorporates a fibre optic cable 8 whose end remote from the sensor head 14 is connected to an optical measurement system 9. Protruding through the sensor head 7 is a hollow glass sphere 10 which is in contact with the other end of the fibre optic cable 7.

In use, the sphere 10 is held in intimate contact with the patient's skin immediately over a blood vessel. Pressure variations resulting from blood flow cause variations in the diameter of the sphere 10. The sphere is interrogated, optically, via the fibre optic cable 8. As the walls of the sphere 10 act as two reflective surfaces of an interferometer, by monitoring the sphere's reflection spectrum, blood pressure can be measured.

Referring now to Figure 3, a hollow hypodermic needle 11 houses a fibre optic cable 12 which incorporates a grating 13. One end of the fibre optic cable 12 (adjacent to the needle tip) terminates in a hollow glass sphere 14. The other end of the fibre optic cable 12 is connected to an optical measurement system 15.

In operation, the needle 11 is inserted via the skin into a blood vessel. By monitoring the Bragg wavelength of light reflected from the grating 13, the temperature of the blood at the fibre tip can be determined. By simultaneously monitoring the reflections from the hollow sphere 14, blood pressure can also be determined.

Referring to Figure 4, this embodiment comprises a hollow glass sphere 16 in which is secured a portion of a fibre optic cable 17. The portion of cable inside the sphere 16

incorporates a grating 18 and the end of the fibre cable 17 remote from the sphere 16 is connected to an optical measurement system 19. The sphere 16 and fibre optic cable 17 are located within a hypodermic needle 20. The needle tip and sphere 16 are coated with polyurethane.

In use, with the needle tip inserted into a blood vessel, pressure exerted on the sphere 16 causes it to compress and thereby, compress the portion of cable 17 incorporating the grating 18.

As the mechanical compliance of the sphere 16 is higher than that of a fibre optic cable on its own, the sphere acts as a mechanical amplifier. Pressure sensitivity is therefore enhanced, compared with the first embodiment. Temperature sensitivity is not enhanced however, owing to the similar thermal expansion coefficients of the fibre optic cable 17 and sphere 16. The optical measurement system 19 monitors changes in the Bragg wavelength of the grating 18, thereby providing a measurement of blood pressure.

CLAIMS

1. A device for measuring blood pressure in a human or animal body comprising hollow needle means for insertion into a blood vessel and a fibre optic cable located within the hollow needle means wherein the fibre optic cable incorporates pressure sensing means.

2. A device as claimed in claim 1 in which the hollow needle means comprises a hypodermic needle.

3. A device as claimed in claim 1 in which the hollow needle means comprises a catheter.

4. A device as claimed in any preceding claim in which the tip of the hollow needle means is coated with blood-compatible polymer material.

5. A device as claimed in any preceding claim in which the hollow needle means incorporates a material which is opaque to X-rays.

6. A device for measuring blood pressure in a human or animal body comprising a sensor head for external use incorporating a fibre optic cable wherein the fibre optic cable incorporates pressure sensing means.

7. A device as claimed in any preceding claim in which the pressure sensing means comprises an optical grating written into the fibre optic cable.

8. A device as claimed in any of claims 1 to 6 in which the pressure sensing means comprises a hollow glass sphere in

which is secured a fibre optic cable incorporating an optical grating.

9. A device as claimed in either of claims 7 or 8 in which the optical grating is formed by a variation in the refractive index of the core of the fibre optic cable.

10. A device as claimed in any of claims 1 to 6 in which the pressure sensing means comprises a hollow glass sphere which is bonded to one end of the fibre optic cable.

11. A device as claimed in either of claims 8 or 10 in which the hollow glass sphere is coated with blood-compatible polymer material.

12. A device as claimed in any preceding claim in which an end of the fibre optic cable is coated with blood-compatible polymer material.

13. A device as claimed in either of claims 4, 11 or 12 in which said blood-compatible polymer material is polyurethane.

14. A pressure measuring device substantially as hereinbefore described with reference to the drawings.

The Patent Office

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Application No: GB 9626232.4 **Examiner:** Glyn Hughes
Claims searched: 1 to 5, 7 to 14 **Date of search:** 3 April 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): G1A (AAMA, AAMB, AAMX)

Int Cl (Ed.6): A61B (5/02, 5/021, 5/0215)

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	WO 88/00023 A1	(RADISENSOR) see figure 1 and page 3 line 20 to page 4 line 14	1 - 3
X	US 4873989	(EINZIG) see column 6 line 33 to column 7 line 53	1 and 3
X	US 4691709	(COHEN) see figure 2	1 and 3
X	US 4599901	(HIRSCHFELD) see figure 4	1, 3, 10

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.